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THE MEASUREMENT OF OUTPUT IN THE SERVICE INDUSTRIES:

WITH SPECIAL REFERENCE TO FORMAL SCHOOLING

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THE MEASUREMENT OF OUTPUT IN THE SERVICE INDUSTRIES: WITH SPECIAL REFERENCE TO FORMAL SCHOOLING*

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In the study of the distribution of output in the service industries, one of the major problems, if not the major one, is the identification and measurement of output. Years of schooling has been a useful, if not ideal, measure of educational output in aggregate studies which have estimated the returns to schooling through the use of years of schooling as an input in aggregate production functions [5,6], or the estimation of income profiles by years of schooling [1,9]. Where the objective is to compare the output of different schools, however, there is substantial evidence which indicates that years of schooling is not an adequate measure of output. For example, income data indicate substantial differences in earnings among persons with the same number of years of schooling.

In the study of water systems, gallons of flow may be adequate as a measure of output in some problems, but almost certainly is not in the study of city water systems where factors such as bacteria content and taste are important. The rate at which a city sewage system can dispose of sewage is not the only relevant dimension of the output of sewer systems. The final product(s) coming out of the treatment process may be of equal or of greater importance. The basic problem is: How can the relevant dimensions of the output of a service be identified and used in the study of a service industry?

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The purposes of this paper are twofold. First, conceptual frameworks for educational production functions and educational cost functions are developed from the theory of production and cost. From these two frameworks, conclusions are drawn with respect to the kinds of measures of educational output needed and the problems which may remain after "good" measures of educational output have been obtained. Second, some of the measures of educational output which are currently being used or are empirically possible are evaluated on the basis of the production and cost frameworks.

Educational Production Functions

Conceptually, the relationship between the output of education and the inputs necessary to produce the output, the production function, is similar to the relationship between the output of a physical good and the inputs necessary to produce the physical good:

(1) $Y = f(X_i)$,

where Y is output and the X_i are inputs. For education, Y is defined as the stock of potential knowledge produced. This is analogous to a production function for corn, for example, where the relationship between the number of bushels produced and the inputs to produce the corn are studied. A formulation such as equation (1) allows separation of the actual production of a good from the consumers' evaluation of the flow of services resulting from the good, i.e., the utility function.

If education were a homogeneous good and the school system operated in a competitive market, equation (1) might be an adequate formulation of the educational production function. However, there are many types of knowledge and the school system more closely approximates a system of local monopolies.

There are restrictions on the transfer of students from one public school to another, especially when it involves moving from one school district to another, and relatively high costs involved in attending a private school. Further, a critical characteristic of knowledge is that it cannot be stored, except by a person. Therefore, the production of a stock of knowledge requires a direct recipient who desires to acquire the knowledge being expounded. A teacher in a lecture can put forth much potential knowledge, but if there is no audience, no knowledge is produced.[1] The amount of knowledge produced, then, depends on willing recipients, and the willingness of recipients to acquire knowledge depends on the kinds of knowledge being produced. This implies that the utility function of an individual or a group and the mix of knowledge produced by a school enter in the determination of the amount of knowledge actually transferred to students. The production function for knowledge acquired by students can be written:

(2) $Y^* = g(Y,M,U) = g[f(X_i), M,U]$

where Y^* is the stock of knowledge accumulated by students, M is the mix of knowledge produced, and U is the relevant utility function.

If it can be assumed that all students in school desire to acquire some mix of knowledge, equation (2) has an important message. Y^* is essentially what is measured as educational output.[2] Assuming a "good" broad measure of Y^*

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[1]This characteristic is true in varying degrees of the goods included in the public services group. Some of the goods can be stored only by the consumer of the good, others by the producer, still others by both the consumer and the producer, and some cannot be stored at all. The essential characteristic, however, is that the consumer's evaluation of the good is a direct determinant of the quantity of the good available. For example, the quantity of water produced by a water system is determined not only by the physical volume of the water, but also by the taste and bacteria characteristics of the water.

[2]The various measures of Y^* are evaluated below.

for the moment, the importance of M and U in explaining Y^* should decline the more responsive are schools in providing the mix of knowledge demanded by students, i.e., as schools become more responsive, Y^* approaches Y (potential output) and the technical production function represented by equation (1) is approached. If schools are not responsive to student demands for knowledge, then M and U can be expected to be important, and possibly even dominate, in educational production functions.

This formulation provides an alternative explanation for research on educational production functions using an equation of the form:

(3) $Y^* = h\ (X_i, Z_i)$,

where the Z_i represent social background variables, and may be said to represent the utility function, among other things [2,4,8]. The relative importance of social background variables in this research may indicate a lack of responsiveness to student demands on the part of the schools.

The major conclusion of this section is that a modified production framework is required for educational production functions. A framework similar to the technical production function of physical goods is not possible because the potential output (Y) of a school cannot be observed; only the amount of knowledge transferred to students (Y^*) can be observed. The obvious implication of this framework for measurement is that the measure of Y^* must be proportional to the amount of knowledge received by students from the schools.

Two reasons have generally been advanced for the entrance of the utility function (or variables of the utility function) in educational production functions. First, the measure of Y^* may include knowledge gained outside of school.[3] Second, different students may demand differing quantities of

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[3]See note 2.

knowledge. The above framework adds a third reason. The utility function may enter equation (2) jointly with a variable or function representing the mix of knowledge. The basic hypothesis advanced is that the more closely the mix of knowledge produced by a school approaches that desired by the student, the more closely the student approximates his maximum utility level and the more closely equation (2) approximates equation (1). However, even when schools respond to student demands, the first two reasons may still cause the utility function to enter the educational production function.

Educational Cost Functions

For physical goods, very little work has been done in identifying the cost structure of firms or industries, except through the production function. This has occurred mainly because it has been easier to work with the production function than with cost functions. This may not be true of the service industries.

In the physical goods industries, aggregation of output for the purpose of estimating a single product production function, although troublesome in some cases, has not been unduly restrictive. However, in the service industries, this is a very restrictive problem, not because of a lack of knowledge of how to aggregate, but of what to aggregate. The problem is more easily illustrated for water than for education. If it is assumed that there are three relevant dimensions for water output: gallons of flow, taste, and bacteria content, the problem is to aggregate these three dimensions into one measure of output for water. Although it may be possible to scale the bacteria content along with gallons of flow, it is probably impossible to devise a general taste scale, as it is not known what is good relative to bad tasting water. The advantages of working in a cost framework of the form:

(4) $C = k(Y_i^*, W_i)$,

where C is cost, total, variable, or average, Y_i^* is a set of observable output variables, and W_i is a set of shift variables; is that it is not necessary to know what is good or bad. In a cost framework, it is possible to enter different dimensions of output as separate variables and to determine individual impacts of each variable on cost. In the case of water, for example, it is possible to enter an output variable representing different taste characteristics of water and to determine the impact of different taste characteristics on cost without saying anything about how the taste of water is evaluated by consumers.

For education, different dimensions of school output can be entered to determine individual impacts on cost. For example, school size and dropout rates might be entered as measures of two dimensions of school output. In general, a cost function allows a broader range of experimentation for the investigation of different dimensions of output without requiring aggregation or a scaling of variables.

A second important advantage of a cost framework over a production framework is that the utility function does not enter the cost function. The impact of the utility function is reflected only in the variables determining cost (Y_i^*, W_i). For example, the utility function may affect dropout rates, but this does not affect the ability to determine the impact of varying dropout rates on school cost. Or the utility function may affect the wage rates of teachers in ghetto schools, but this does not affect the determination of the impact of teacher salaries on cost.

Cohn [3] has estimated an average cost function for Iowa high schools using the number of students as a measure of output. His purpose was to determine economies of scale. However, this appears premature as it will be necessary to discover the relevant dimensions of educational output before it is possible to analyze economies of scale.

Measures of Output

Before educational production and cost functions can be identified, good measures of the stock of knowledge produced or transferred to students (Y^*) must be developed. The various measures are discussed as measures of variation of output per student and, in some cases, per year of schooling. It is a relatively easy step from this type of variable to a variable representing the total output of a school.

As stated above, the measures of output used may contribute to the importance of M and U in an educational production function. This happens when the measures include knowledge other than that acquired through the school. In a cost function, such measures will show a lesser association with cost than if only knowledge acquired in school is included. The objective in developing a variable to represent Y^* is to develop a variable which is proportional only to the knowledge acquired by students in school.

Three types of measures of Y^* are discussed: achievement tests, expenditures, and attendance-dropout rates. None of these measures are particularly encouraging.[4]

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[4] It is easier to criticize existing measures than to develop new ones. However, it is hoped that a constructive criticism of existing measures will stimulate new ideas.

The use of achievement test scores as a measure of school output is subject to several serious shortcomings [2,4,8].[5] First, achievement tests are too narrow a measure of knowledge, being designed to measure only certain kinds of knowledge, usually basic skills in reading comprehension and mathematics. The results of these tests are biased in favor of those students who demand this type of knowledge and against more technically oriented students. Since students tend to be clustered by types of knowledge demanded, variables representing the utility function of an individual or a school are likely to be significant in production functions using test scores as the measure of output. Second, test scores are not direct measures of school output, but measures of the total knowledge acquired by the student up to the time of the test. Even using changes in test scores from one period to another does not eliminate this problem. Finally, achievement tests are designed to accurately test only those students with some average level of ability. There is not agreement that relative variations in test scores represent relative variations in achievement by students or groups of students [8].

Expenditures as a measure of output are discussed only because of the scarcity of output measures. They are relevant only as a measure of output in production functions. If expenditures are proportional to any of the outputs discussed above, they are probably proportional to potential knowledge, i.e., Y in equation (1). However, two probably unjustified assumptions are required: constant returns to scale in the production of knowledge and the efficient operation of schools.

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[5] Achievement test scores are criticized only on the basis of their use as a measure of school output. This is not meant to depreciate the importance of a broader and equally important question: that of explaining total student achievement.

Katzman obtained relatively good results from three measures derived from attendance-dropout rates: the ratio of average daily attendance to average daily membership, the ratio of average daily membership to beginning of year enrollment, and continuation or non-dropout rates [7].[6] These measures hold perhaps the greatest hope for the measurement of school output because they are broad, representing in a sense the overall attraction of a school. They are also more direct measures of school output than achievement tests, as knowledge acquired outside of school does not enter the measures directly. The basic logic of these measures is that the greater the potential knowledge available (Y) and the more desirable the mix of knowledge (M), the more time students will spend in school.

The most serious shortcoming of these measures is that they are subject to illness rates and migration rates which cannot be eliminated from the data. Migration of families to or from particular school districts is expected to affect greatly measures of continuation rates in these districts.

Conclusions

There are several implications for further research in this paper. The first and most obvious is the need for the development of better measures of the output of schools; better measures of the amount of knowledge transferred to students in, and only in, the schools. However, even "good" measures of output may not eliminate the utility function from educational production functions. It may be possible to at least derive some conclusions as to the

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[6] These measures are of particular interest to the author because they represent a set which can be developed from the Ohio data for the total public school system.

relative importance of the remaining two reasons for the utility function in educational production functions (the demand for differing quantities or mixes of knowledge) from the direct study of students. The objective of such a study would be to determine how much and what kinds of knowledge students with differing backgrounds demand. The results of such a study could then be compared to the kinds of programs available in the schools the students attend.

A second approach which may eliminate the effect of utility functions is the study of educational cost functions. In a cost function, the variables most affected by the utility function enter as determinants of cost and not as the major variable to be explained.

Many of the major problems in the study of other public services parallel those of education. Some of the problems in water and sewer systems which parallel those of education have been mentioned.

References

1. Becker, Gary S., Human Capital, New York: National Bureau of Economic Research, 1964.

2. Bowles, Samuel, "Towards an Educational Production Function", Paper presented at the NBER Conference on Education and Income, Madison, Wisconsin, 1968.

3. Cohn, Elchanan, "Economies of Scale in Iowa High School Operations", Journal of Human Resources, III (4), Fall, 1968, 422-34.

4. Coleman, James S. et. al., Equality of Educational Opportunity, Washington: United States Office of Education, 1966.

5. Griliches, Zvi, "Research Expenditures, Education, and the Aggregate Agricultural Production Function", American Economic Review, December, 1964, 961-74.

6. Griliches, Zvi, "The Sources of Measured Productivity Growth: United States Agriculture, 1940-60", Journal of Political Economy, August, 1963, 331-46.

7. Katzman, Martin T., "Distribution and Production in a Big City Elementary School System", Yale Economic Essays, 8 (1), Spring, 1968, 201-56.

8. Kiesling, Herbert J., "The Relationship of School Inputs and Community Characteristics to Public School Performance", Unpublished paper, Indiana University.

9. Schultz, T. W., The Economic Value of Education, New York: Columbia University Press, 1963.